Aura MLS Near-Real-Time Processing Stream for use in Data Assimilation

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Aura Satellite

NASA's Earth Observing System (EOS) Aura satellite, launched on 15 July 2004, is operated in a 98 deg inclination sun-synchronous orbit at an altitude of 705 km with a 13:35 ascending-node time. The Microwave Limb Sounder (MLS) (Waters et al., 2006) is one of four instruments on board the Aura platform, whose main mission objectives are studying ozone, air quality and climate (Schoeberl et al., 2006).

MLS detects thermal microwave emission from the Earth's limb and retrieves vertical profiles of atmospheric temperature and composition in the vertical range 8–90 km (Livesey et al., 2006).

The Earth Observing System (EOS) Aura satellite is dedicated to the study atmospheric chemistry and the effect of pollutants on the Earth's climate.

Aura Microwave Limb Sounder

The Aura Microwave Limb Sounder is an advanced successor to the MLS instrument on the Upper Atmosphere Research Satellite (UARS) and measures thermal emission at millimeter and sub-millimeter wavelengths using seven radiometers to cover five broad spectral regions.

The radiometric and spectral performance of the MLS instrument is described in detail by Jarnot et al. (2006) for the GHz radiometers.

Motivation for assimilation of research satellite data

Achieve a decrease in the mean analysis error and standard deviation for the assimilated fields

Less dependence on background error covariance

Improve the operational forecast skill

Improvements in the temperature, radiation and heating fields internal to the model

Decrease the residuals of the assimilated operational satellite radiance data sensitive to ozone

Improvements in air quality prediction through the estimation of tropospheric ozone

Improve wind analyses indirectly in the upper troposphere and lower stratosphere through improvements in tracer fields

More accurate regional and global forecasts of surface UV radiation

Provide chemical constraints for unobserved constituents

Better description of stratospheric dynamics

Better planning and support of large coordinated atmospheric measurement campaigns

Aura MLS standard data products

MLS limb radiance measurements are inverted using an optimal estimation retrieval in the Level-2 operational processing stage

Standard MLS processing suite is not practical for processing a NRT data stream

Large demands on computational resources

Inherent latency of about one day

Aura MLS Near Real Time Products

Objective is to produce NRT data products from Aura MLS that can be assimilated into operational analysis schemes

Data products with appropriate accuracy, precision, vertical resolution for the purposes intended and quality controlled

Produced with low latency and realistic machine processing requirements

Aura MLS Data Processing System

Science Computing Facility (SCF)
- Provides services and resources for algorithm development
- Processing software development
- Investigation of quality control
- Scientific data analysis

Science Investigator-led Processing System (SIPS)
- Interfaces to GES-DISC
- Software developed on SCF is run in the operational environment
- Processing streams for data versions v2.2 and v3.3

SIPS Modifications for NRT Processing

TData throughput, reliability and low-latency is maintained by an independent NRT operational system at the MLS SIPS

he NRT system was developed as a customized SIPS with expedited processing requirements enabling the tranformation of Level 0 data up through Level 2 and distribution of science data products to the customer within a few hours of the satellite measurements

Additional interface to GES-DISC for MLS SIPS

NRT Level-0 data product

- Constructed from satellite and instrument Rate Buffered Data (RBD)
- Handling of time-gaps, glitches and repeated data records
- Sub-divide the orbit contacts (100 mins) into Level-0 NRT files with a granularity of about 15 minutes each
- Use predictive ephemeris and orbit / attitude data

Modifications to produce a Level-1 NRT processor

Only calibrate selected GHz radiances needed for NRT products
- Ingest NRT Level-0 and orbit/ephemeris data
- Output Orbit and Attitude data
- Output GHz radiance data

Modifications to produce a Level-2 NRT processor

Ingest NRT Level-1 GHz radiances and orbit/attitude data
- Addition of fast forward model
- Output the NRT Level-2 products

Retrieval of MLS NRT data products

Modified Level-2 algorithms for NRT data processing for a subset of the Aura MLS data products
- 1D homogeneous line-of sight

Temperature is retrieved from the 118-GHz region using a fast linear, non-polarized forward model.

H_2O, N_2O and HNO_3 are retrieved from the 190-GHz region

O_3, CO, SO_2 and HNO_3 are retrieved from the 240GHz region

Comparisons of NRT products with standard processed data

NRT examples for June 3, 2011

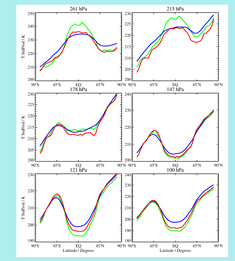
Zonal mean differences between the new v3.40-NRT, v2.20-NRT and the v3.3 standard products.

1D retrievals can lead to artefacts in the presence of large line-of-sight gradients.

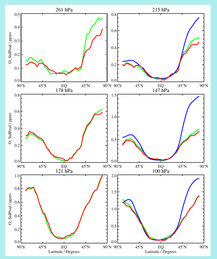
For pressures less than 0.3 hPa (not shown) the Zeeman split O_2 spectral line used for the temperature retrieval requires a polarized forward model to achieve greater accuracy in the Upper Stratosphere and Lower Mesosphere.

Standard product version v3.3
Near-Real-Time updated version v3.40-NRT
Near-Real-Time previous version v2.20-NRT

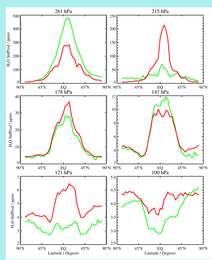
Temperature
Usable range: 215 hPa to 1 hPa
Vertical resolution: 3-5 km



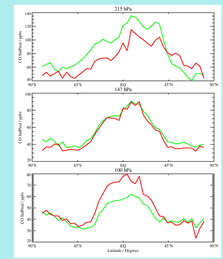
Ozone
Usable range: 261 hPa to 0.1 hPa
Vertical resolution: 2.5-3.0 km



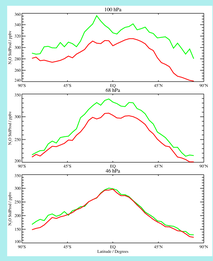
Water Vapor
Usable range: 147 hPa to 1 hPa
Vertical resolution: 2.1-3.5 km



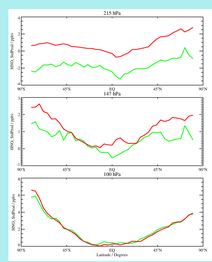
Carbon Monoxide
Usable range: 215 hPa to 0.1 hPa
Vertical resolution: 5-5.5 km



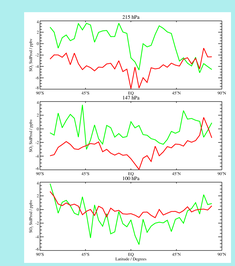
Nitrous Oxide
Usable range: 100 hPa to 1 hPa
Vertical resolution: 4.7-8.5 km



Nitric Acid
Usable range: 100 hPa to 1.5 hPa
Vertical resolution: 3.0-5.0 km



Sulfur Dioxide
Usable range: 215 hPa to 10 hPa
Vertical resolution: 3.0-3.7 km



Aura MLS NRT Data Access

MLS Near Real Time (NRT) systems at GES DISC are components of the Land and Atmosphere Near real time Capability for EOS (LANCE).

In accordance with NASA policy, user registration has been implemented for access to NRT data processed and distributed through all LANCE elements.

NRT data are available via FTP at discnrt1.ecs.nasa.gov and discnrt2.ecs.nasa.gov. The same data products are available from either redundant server.

Aura MLS Near-Real-Time Ozone and Temperature Data are available via FTP download from GEFC-DISC. Only data from the past 7 days are retained on-line (there are up to 96 files per day per product each containing 15 minutes of data). However, the MLS team can provide historical NRT data (in daily files) for offline testing purposes.

NRT Latency
Most of the data granules are processed within 5 h of the satellite measurements and 80% are processed within 3 h.

MLS NRT data routinely are downloaded from GES-DISC by several world-wide operational NWP centers and are under active evaluation in assimilation trials.

http://disc.sci.gsfc.nasa.gov/Aura/data-holdings/MLS

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